INFLUENCE OF NANO TiO_2 ON GEOPOLYMER CONCRETE

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ABSTRACT-Geopolymer concrete (GPC) is cement less concrete. It has the potential to minimize global emissions that lead to a sustainable development and growth of concrete industry. This paper evaluates the effect of different percentages of nano $TiO_2$from 1 to 5% inground granulated blast furnace slag (GGBS) based geopolymer concrete.GPC with 10M concentration along with Na_2SiO_3 / NaOH ratio 2.5 were carried out for the study. Mechanical properties of GPC such as compressive,flexural and split tensile strengths were studied for addition of nano TiO_2. The results depicted that, up to 3% addition of nano TiO_2, all mechanical properties are increased and there after decreased.

***KEYWORDS:*GPC, GGBS,nano Tio_2,sodium silicate, sodium hydroxide, compressive strength, Flexural strength, Split tensile strength**

1. INTRODUCTION

Ali Nazari et al. [1] have carried strength assessments of self compacting concrete containing different amounts of GGBS andnano Tio_2 particles as binder. Portland cement was replaced by 45 % of GGBS and up to 4 % Tio_2 and the properties of concrete specimens were investigated. Nano particles as a partial replacement of cement up to 3wt% could accelerate C-S-H gel formation and improve the resistance to water permeability of concrete specimens.

Lee et al. [2] showed that setting time decreased with amount of slag and the concentration of the NaOH solution increased. Parthiban et al. [3] dissected that compressive strength improves with increase in alkaline ratio along with decrease in workability and also stated that the admixture (Glenium B-233) does not exhibit any subsequent improvement in strength besides increase in workability of concrete.

Rajini et al. [4] have concluded that GPC with fly ash 0% and GGBS 100%, compressive and split tensile strengths were optimum irrespective of curing period. The strength improvement of geopolymer concrete was very rapid before 7 days.Aravindan et al. [5] carried experimental investigation of alkali-activated slag and fly ash based geopolymer concrete.AAS-FA based geopolymer concrete got more strength when compared with that of conventional concrete.

ParasPithadiya et al. [6] deliberated that compressive strength increases gradually for the alkaline ratio of 1.5 to 2.5 and thereafter declined up to 3.5 with optimum Na_2SiO_3 / NaOH ratio was found to be at 2.5.Yang et al. [7] experimental results indicated that the addition of nano TiO_2 to alkali activated slag paste (AASP) enhances the mechanical strength, and decreases the shrinkage. Results demonstrated that the addition of nano TiO_2 into AASP accelerates its hydration process, resulting more hydration products and denser structure.

Abhilash et al. [8] studied that as percentage of GGBS increased, mechanical properties were also increased.Arie Wardhono et al. [9] compared the long term performance between alkali activated slag and fly ash geopolymer concretes. The results showed that the AAS concrete had higher compressive and tensile strength, elastic modulus and lower penetration characteristics than that of FAGP concrete.

2. EXPERIMENTAL STUDY

2.1 MATERILAS

2.1.1 GGBS

Ground Granulated Blast Furnace Slag obtained from JSW steel Ltd, Bellary used for the present study.

2.1.2 Aggregates

Locally available Fine aggregate of size less than 4.75 mm and coarse aggregate of 20 mm down were used for present study.

2.1.3 Alkaline Solutions

Combination of sodium hydroxide of 10M and sodium silicate solutions containing H_2O of 49.2%, SiO_2 of 34.3% and Na2O of 16.7% used in alkaline activator preparation.

2.1.4 Nano titanium dioxide

Nano Tio_2 particle size ranging from 40 nm to 80 nm was used in this study.

2.1.5 Admixture (Glenium B-233)

Glenium B-233 super plasticizer was used in this work.

2.2 Mix Design

GGBS based geopolymer concrete mix design with 10M was done with alkaline ratio 2.5 considering combined mass of aggregate 77% of unit weight of GPC. In combined mass of aggregate, 70:30 ratio of coarse aggregate and fine aggregate were used. Alkaline liquid to binder ratio of 0.55was considered in the present study. nano $TiO_2$was added to GPC mix in ratio 1 to 5 with increment of 1%. Fig 1 shows the GPC samples during mixing, vibration.

Fig 1 Mixing, Casting and Curing of geopolymer concrete specimens

2.3 Testing

Compressive strength test was performed in accordance with IS 516: 1959. The test was performed on 150*150*150 mm cubic samples at 28 days.Compressive strength of each mix was taken as average value of three specimens. The flexural strength of the geopolymer concrete was carried out as per IS 516: 1959. Beams of size 500×100×100mm size were cast then subjected to the flexural strength test using universal testing machine (UTM) at the age of 28 days.The split tensile strength test was carried out as per IS 5816: 1999. Cylindrical specimens of size 150mm diameter and 300 mm height were cast. The specimens were then tested for 28 days splitting tensile strength using universal testing machine (UTM).

2.4 RESULTS AND DISCUSSIONS

Compressive Strength

Mechanical properties of GGBS based GPC using different % of TiO_2 are depicted in Table 1. Fig 2 explains the variation of compressive strength of geopolymer concrete with and without adding of nano TiO_2 at 28 days. At 3% of nano TiO_2 percentage development in compressive strength of GPC is maximum and is 21% over the control GPC after that the compressive strength decreases.

Table 1 Mechanical properties of GGBS Based GPC with Nano TiO_2

Mixture	Compressive strength (MPa)	Flexural strength (MPa)	Split Tensile strength (MPa)
	28 days	28 days	28 days
G100NT0(control GPC mix)	67	7.8	4.0
G100NT1	76	9.0	4.3
G100NT2	79	9.09	4.4
G100NT3	**81**	**9.1**	**4.6**
G100NT4	73	8.4	4.2
G100NT5	68	7.9	4.1

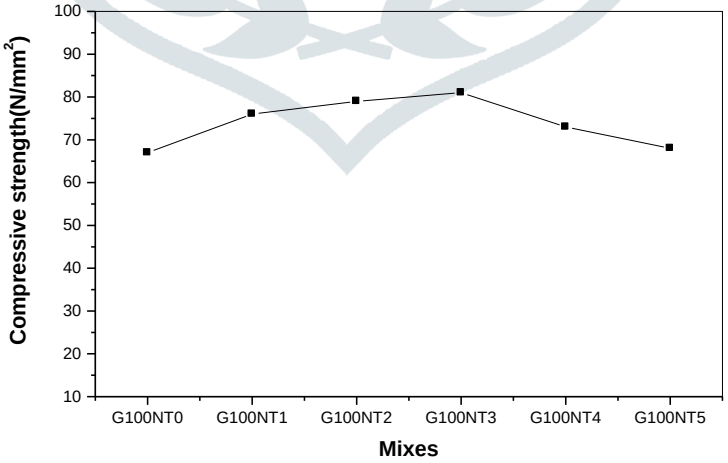

Fig 2 Variation of 28 days compressive strength of GPC with nano TiO_2

Flexural strength

Fig 3 represents the variation flexural strength of geopolymer concrete with and without nano titanium dioxide. Table 1 depicts the variation of flexural strength of GGBS based GPC using nano TiO_2. At 3% of nano TiO_2 % improvement in flexural strength of geopolymer concrete is maximum and is 17.5% over control GPC.

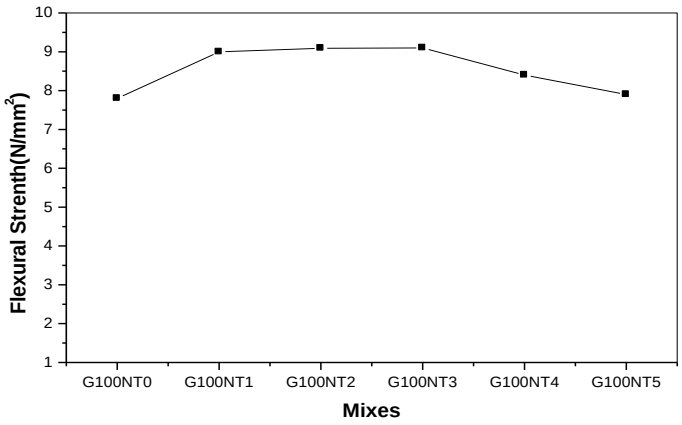

Fig 3 Variation of 28 days flexural strength of GPC with nano TiO_2

Split tensile strength

Fig 4 indicates the variation of spilt tensile strength of geopolymer concrete with different % addition of nano TiO_2. Variation of split tensile strength of GPC using TiO_2 is shown in Table 1. At 3% of nano TiO_2 % improvement in split tensile strength of GPC is maximum and is 14.76% over control GPC.

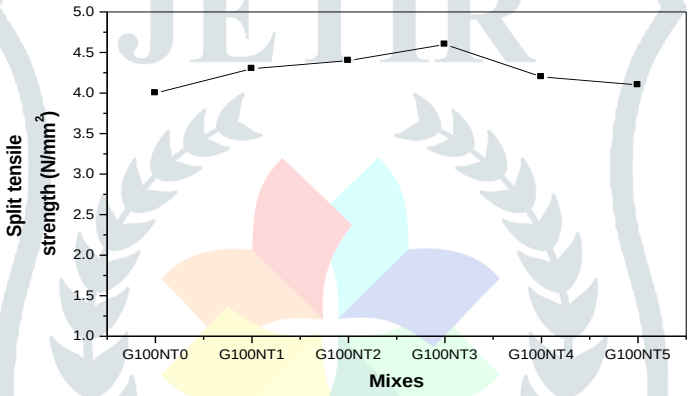

Fig 4 Variation of 28 days split tensile strength of GPC with nano TiO_2

SUMMARY AND CONCLUSIONS

Mechanical properties of GGBS based GPC with nano TiO_2were studied.The following conclusions are proposed based on the experimental study

- Up to 3% addition of nano Tio_2 the compressive strength, flexural strength, and split tensile strengths of GPC were increased and that decreased.
- As the % addition of nano TiO_2increased, decrease in workability of GPC was observed.
- Based on the limited experimental study, it was concluded that, addition of 3% nano titanium dioxide in GGBS based GPC, improves compressive, Split tensile and Flexural Strengths 21%, 14.7% and 17.5% over respective strengths of controlled GPC mix.

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